Chemistry 101
ANALYSIS BY TITRATION
Pre-Lab Exercises

Student:___________________________
Date:______________________________
Instructor:__________________________
Section:____________________________

1. Why is an indicator used in an acid base titration?

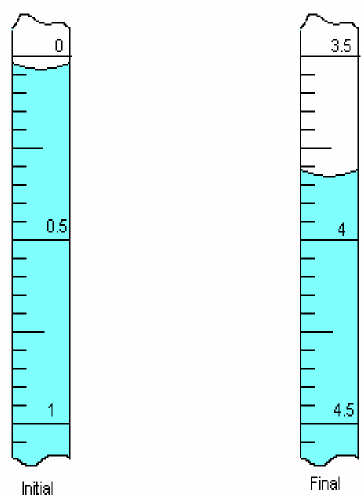
2. What is a standardized solution?

3. How many moles of nitric acid are in 319.65 mL of 12.2 M nitric acid?

mol

4. If 8.25 mL of 0.25 M citric acid reacted completely with 6.35 mL of 0.97 M NaOH, what is the mole ratio between citric acid and NaOH?

5. Read the initial and final buret values and calculate the volume of solution discharged from the buret to the nearest 0.01 mL.



mL

Chemistry 101
ANALYSIS BY TITRATION

Student:__________________________
Partner:___________________________
Instructor:_________________________
Section:___________ Date: ___________

OBJECTIVES

To determine the mole ratio for the reaction between tartaric acid and sodium hydroxide
To determine the percent acetic acid in vinegar solution

PROCEDURE AND REPORT

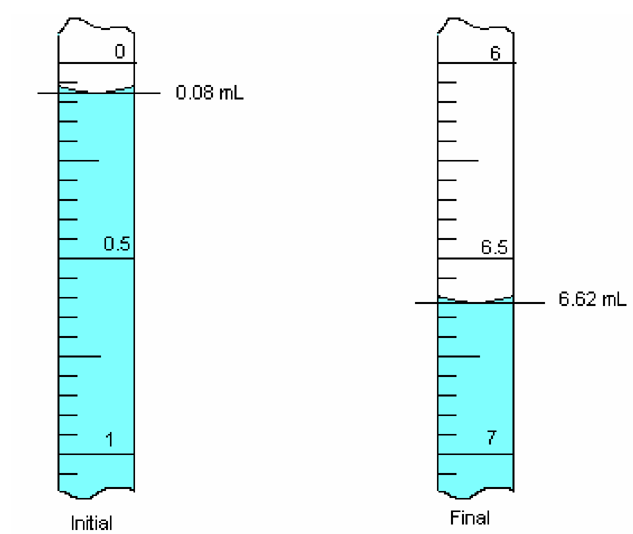
Determination of the Mole Ratio between Tartaric Acid and Sodium Hydroxide

Tartaric acid ($C_4H_6O_6$) reacts with sodium hydroxide to form water and an unknown product.

$$x\ C_4H_6O_6 + y\ NaOH \rightarrow H_2O + ??????$$

Since the product is not known, the equation cannot be balanced without performing an experiment to determine the combining ratio of the two reactants. In this experiment you will determine the mole ratio between tartaric acid and sodium hydroxide by adding solutions of known concentration (standardized solutions) of each chemical until they react completely. The procedure of reacting known volumes of solutions to perform an analysis is generally called titration. From the amounts of chemicals needed to react completely we can determine the values of x and y in the balanced equation. Since the reactants in this reaction are both colorless, it is not possible to visually determine when the two chemicals have reacted completely. Therefore, an indicator is needed to detect the reaction end point. The indicator used in this experiment is phenolphthalein that is colorless in tartaric acid and pink in NaOH. When sufficient NaOH is added to completely react with the tartaric acid, the color of the solution will change from colorless to pink.

The figure to the right illustrates how to make readings using the burets. Each calibrated increment is 0.05 mL. Readings should be made at the bottom of the meniscus with estimates being made to the nearest 0.01 mL. In the example shown, the initial volume is 0.08 mL and the final volume is 6.62 mL. The volume discharged from the buret is therefore 6.62 mL – 0.08 mL = 6.54 mL.



Determination of the Mole Ratio between Tartaric Acid and Sodium Hydroxide (Cont.)

1. Record the molarity of the tartaric acid and sodium hydroxide solutions.
2. Drain the water from the two burets. Rinse one of the burets with several small samples of the tartaric acid solution and the other buret with several small samples of the sodium hydroxide solution. Be sure that no air bubbles remain in the tips of the burets and fill both burets to near zero with their respective solutions.
3. Record the initial readings on both burets to the nearest 0.01 mL.
4. Drain about 8 mL of tartaric acid solution from the buret into a 50 mL flask. Add 1 drop of phenolphthalein indicator. Add NaOH from the other buret while you swirl the flask. Occasionally rinse the insides of the flask with a little distilled water from a wash bottle. Continue adding NaOH until one drop causes the solution to change from colorless to very light pink. If you miss this point, add a few drops more from the tartaric acid buret. Add NaOH if necessary until a faint pink color remains. Record the final volumes on both burets to the nearest 0.01 mL.
5. Calculate the volumes of the tartaric acid and sodium hydroxide solution that were used in the titration.
6. Using the volume and molarity of each solution, calculate the moles of each reactant used. Remember to convert the volumes to liters. (concentration (M) x volume (L) = mol)
7. Divide the moles of NaOH by the moles of tartaric acid to determine the mole ratio.
8. Discard the contents of the flask and wash it with tap water. Repeat the titration at least 2 more times.
9. Calculate the average mole ratio.
10. Determine the values of x and y in the balanced equation.

Molarity of $C_4H_6O_6$: ______________M

Molarity of NaOH: _______________M

	Trial #1	Trial #2	Trial #3
Final $C_4H_6O_6$ buret reading			
Initial $C_4H_6O_6$ buret reading			
Volume of $C_4H_6O_6$ used			
Final NaOH buret reading			
Initial NaOH buret reading			
Volume of NaOH used			
Moles of $C_4H_6O_6$ used			
Moles of NaOH used			
Mole ratio: NaOH/$C_4H_6O_6$			
Average mole ratio			

Fill in the coefficients: ____ $C_4H_6O_6$ + ____ NaOH → H_2O + ??????

Calculations:

Analysis of Acetic Acid in Vinegar

Vinegar is a dilute aqueous acetic acid ($HC_2H_3O_2$) solution. It reacts with sodium hydroxide as follows:

$$HC_2H_3O_2 + NaOH \rightarrow NaC_2H_3O_2 + H_2O$$

In this experiment you will analyze a vinegar solution to determine the percent acetic acid. As before, phenolphthalein will be used to signal when the acetic acid has reacted completely.

1. Tare an empty 50 mL flask. The flask needs to be dry on the outside but not on the inside. Add about 2 grams of vinegar to the flask and record the mass of the solution to the nearest 0.01 g.
2. Add one drop of phenolphthalein solution. Add NaOH from the buret while you swirl the flask. Occasionally rinse the insides of the flask with a little distilled water from a wash bottle. Continue adding NaOH until one drop causes the solution to change from colorless to very light pink. **This time you cannot correct if you make the solution too pink**. Record the final volume of NaOH to the nearest 0.01 mL.
3. Calculate the volume of NaOH used.
4. From the volume and the molarity of the NaOH calculate the moles of NaOH that reacted.
5. Use the mole ratio from the chemical equation to calculate the moles of $HC_2H_3O_2$ that were in the vinegar solution.
6. Use the molar mass of $HC_2H_3O_2$ to calculate the mass of $HC_2H_3O_2$ in the vinegar solution.
7. Use the mass of $HC_2H_3O_2$ and the mass of the vinegar solution to calculate the % $HC_2H_3O_2$ in vinegar.
8. Refill the buret and repeat the experiment at least twice more.
9. Calculate the average % $HC_2H_3O_2$ in vinegar.

Molarity of NaOH: _______________M

	Trial #1	Trial #2	Trial #3
Mass of vinegar			
Final buret reading			
Initial buret reading			
Volume NaOH used			
Moles NaOH used			
Moles $HC_2H_3O_2$ in vinegar sample			
Mass $HC_2H_3O_2$ in vinegar sample			
% $HC_2H_3O_2$ in vinegar			
Average % $HC_2H_3O_2$ in vinegar			

Calculations: